

## CLAIMS

We claim:

1. A computer-based method for assisting at least two parties involved in a negotiation problem with any number of variables in achieving a mutually satisfactory agreement on decisions to be taken on one or more of said variables comprising the steps of:
  - a) providing a negotiation system including at least one programmed computer system and an associated interactive graphical interface for interactive input and output of negotiation information to and from said computer system, said computer system being programmed to
    - display said negotiation information, including packages that each represent a potential agreement on decisions to be taken on one or more of said variables of said negotiation problem in response to entered preference data from each of said parties;
    - generate at least one said package;
    - keep confidential any private information and display that information only to the party to whom that information belongs; and
    - display negotiation information that is not private, including mutually acceptable packages, only to those parties with permission to see that information;
  - b) entering information into said negotiation system through said graphical interface, including information describing the negotiation variables, their relationship to each other, any constraints on the negotiated outcomes of those variables, and information pertaining to each said party's preferences on the outcome of each of said variable;
  - c) optionally entering into said negotiation system through said graphical interface, proposals and/or other packages (which may be declared private);
  - d) in response to said entering of said information, said negotiation system using each party's inputted information to evaluate packages by specifying a level of satisfaction according to each party's own preferences;
  - e) entering into said negotiation system for one or more parties, a confidential acceptable level of satisfaction and, for each of those parties, their willingness for maximum possible corresponding satisfaction levels for other parties to be generated for and revealed to other parties;

- f) given said entered information, for each given said confidential acceptable level of satisfaction declared by said one or more parties, said negotiation system using optimization techniques to generate a fair distribution of maximum possible satisfaction levels for each other party;
- g) revealing said maximum possible satisfaction levels to said other parties;
- h) if and when each of all said other parties to the negotiation (or a subset, if coalitions are allowed) accept the said maximum satisfaction level revealed to that party, said negotiation system using optimization techniques with said entered information to generate an equivalent package that would give at least as much satisfaction to each party as they have declared acceptable;
- i) revealing said equivalent package to all parties concerned;
- j) using each party's inputted information to evaluate said equivalent package in terms of a specified level of satisfaction according to each party's own preferences; and
- k) declaring as a tentative agreement among two or more parties, any package that has been accepted by each of those parties.

2. The computer-based method of claim 1, further including the step of using optimization techniques to generate an improved package that is Pareto optimal (if not already) according to said entered preferences (or changed preferences) and displaying said improved package on said one or more graphical interfaces.

3. The computer-based method of claim 2, wherein said step of providing a negotiation system including at least one computer system and an associated interactive graphical interface further comprises:

- a) providing a plurality of independent, separate computer systems and associated interactive graphical interfaces, one each for each of said parties, each said independent, separate computer system being programmed to receive and process information from each party, including that pertaining to each of said party's preferences on the outcome of each said variable involved in said conflict; and,
- b) providing a central computer system located at a neutral site and a plurality of communication links connecting each of said independent, separate computer systems to said central computer system, said central computer system being programmed to receive

preference information from each of said independent, separate computer systems, generate at least one package representing a potential solution to the negotiation problem in response to entered preference information from each of said independent, separate computer systems, and securely transmit generated information and other information to be communicated between parties;

wherein, the information pertaining to each of said party's preferences remains confidential to each party.

4. The computer-based method of claim 3, further including the step of entering into said negotiation system other information from which said preference information may be derived, in an automated process not requiring a graphical interface.

5. The computer-based method of claim 1, further including the step of entering into said negotiation system other information from which said preference information may be derived, in an automated process not requiring a graphical interface.

6. A computer-based method for assisting at least two parties involved in a negotiation problem with any number of variables in achieving a mutually satisfactory agreement on decisions to be taken on one or more of said variables comprising the steps of:

- a) providing a negotiation system including at least one programmed computer system and an associated interactive graphical interface for interactive input and output of negotiation information to and from said computer system, said computer system being programmed to
  - display said negotiation information, including packages that each represent a potential agreement on decisions to be taken on one or more of said variables of said negotiation problem in response to entered preference data from each of said parties;
  - generate at least one said package;
  - keep confidential any private information and display that information only to the party to whom that information belongs; and
  - display negotiation information that is not private, including mutually acceptable packages, only to those parties with permission to see that information;
- b) entering information into said negotiation system through said graphical interface, including information describing the negotiation variables, their relationship to each other,

any constraints on the negotiated outcomes of those variables, and information pertaining to each said party's preferences on the outcome of each of said variable;

- c) optionally entering into said negotiation system through said graphical interface, proposals and/or other packages (which may be declared private);
- d) in response to said entering of said information, said negotiation system using each party's inputted information to evaluate packages by specifying a level of satisfaction according to each party's own preferences;
- e) entering into said negotiation system for one or more parties, a confidential acceptable level of satisfaction;
- f) said negotiation system attempting to generate an equivalent package that would give at least as much satisfaction to all parties (or a subset, if coalitions are allowed) as they have declared acceptable and if not successful then requiring one or more parties to reduce their declared minimum level of satisfaction, each time attempting again to generate said equivalent package until successful;
- g) when successful in said attempt, then revealing said equivalent package to all parties concerned;
- h) using each party's inputted information to evaluate said equivalent package in terms of a specified level of satisfaction according to each party's own preferences; and
- i) declaring as a tentative agreement among two or more parties, any package that has been accepted by each of those parties.

7. The computer-based method of claim 6, further including the step of using optimization techniques to generate an improved package that is Pareto optimal (if not already) according to said entered preferences (or changed preferences) and displaying said improved package on said one or more graphical interfaces.

8. The computer-based method of claim 7, wherein said step of providing a negotiation system including at least one computer system and an associated interactive graphical interface further comprises:

- c) providing a plurality of independent, separate computer systems and associated interactive graphical interfaces, one each for each of said parties, each said independent, separate computer system being programmed to receive and process information from each party,

including that pertaining to each of said party's preferences on the outcome of each said variable involved in said conflict; and

- d) providing a central computer system located at a neutral site and a plurality of communication links connecting each of said independent, separate computer systems to said central computer system, said central computer system being programmed to receive preference information from each of said independent, separate computer systems, generate at least one package representing a potential solution to the negotiation problem in response to entered preference information from each of said independent, separate computer systems, and securely transmit generated information and other information to be communicated between parties;

wherein, the information pertaining to each of said party's preferences remains confidential to each party.

9. The computer-based method of claim 8, further including the step of entering into said negotiation system other information from which said preference information may be derived, in an automated process not requiring a graphical interface.

10. The computer-based method of claim 6, further including the step of entering into said negotiation system other information from which said preference information may be derived, in an automated process not requiring a graphical interface.

11. A computer-based apparatus for assisting at least two parties involved in a negotiation problem with any number of variables in achieving a mutually satisfactory agreement on decisions to be taken on one or more of said variables, comprising:

- a) a plurality of independent, separate computer systems, one for each of said parties, each said computer system being programmed to receive and process communication between parties and/or other information pertaining to each said party's preferences on the outcome of each variable involved in said negotiation problem, including proposals and confidential acceptance of any package;
- b) a plurality of interactive graphical interfaces connected, one for each of said independent and separate computer systems for input and output of information to and from the corresponding one of said computer systems;

c) a central computer system located at a neutral site for

- processing party preference information received from each of said independent separate computer systems;
- maintaining each said party's preference information confidential from every other one of said parties;
- receiving a confidential acceptable level of satisfaction for an agreement from one or more parties and their willingness for maximum possible corresponding satisfaction levels for other parties to be generated for and revealed to other parties;
- using optimization with given said entered information to generate a fair distribution of maximum possible satisfaction levels for each other party for each given said confidential acceptable level of satisfaction declared by said one or more parties;
- revealing said maximum possible satisfaction levels to said other parties;
- if and when each of all said other parties to the negotiation (or a subset if coalitions are allowed) accept the said maximum satisfaction level revealed to that party, using optimization techniques with said entered information to generate an equivalent package that would give at least as much satisfaction to all parties as they have declared acceptable;
- revealing said equivalent package to all parties concerned; and
- declaring as a tentative agreement among two or more parties, any package that has been accepted by each of those parties.

d) communication link means connecting each of said independent, separate computer systems with said central computer system;

12. The computer-based apparatus of claim 11, wherein said central computer system is further programmed for generating an improved package from said tentative agreement that is Pareto optimal (if not already) according to said entered preferences (or changed preferences) and displaying said improved package on said one or more graphical interfaces.

13. A computer-based apparatus for assisting at least two parties involved in a negotiation problem with any number of variables in achieving a mutually satisfactory agreement on decisions to be taken on one or more of said variables, comprising:

a) a plurality of independent, separate computer systems, one for each of said parties, each said computer system being programmed to receive and process communication between

parties and/or other information pertaining to each said party's preferences on the outcome of each variable involved in said negotiation problem, including proposals and confidential acceptance of any package;

- b) a plurality of interactive graphical interfaces connected, one for each of said independent and separate computer systems for input and output of information to and from the corresponding one of said computer systems;
- c) a central computer system located at a neutral site for
  - processing party preference information received from each of said independent separate computer systems;
  - maintaining each said party's preference information confidential from every other one of said parties;
  - receiving a confidential acceptable level of satisfaction for an agreement from one or more parties; and
  - generating an equivalent package that would give at least as much satisfaction to all parties (or a subset if coalitions are allowed) as they have declared acceptable or, if that is not possible, then requiring one or more parties to reduce their declared minimum level of satisfaction before attempting again to generate said equivalent package, until successful;
  - when successful in said attempt, then revealing said equivalent package to all parties concerned; and
  - declaring as a tentative agreement among two or more parties, any package that has been accepted by each of those parties.
- d) communication link means connecting each of said independent, separate computer systems with said central computer system;

14. The computer-based apparatus of claim 13, wherein said central computer system is further programmed for generating an improved package from said tentative agreement that is Pareto optimal (if not already) according to said entered preferences (or changed preferences).

15. A computer-based apparatus for assisting at least two parties involved in a negotiation problem with any number of variables in achieving a mutually satisfactory agreement on decisions to be taken on one or more of said variables, comprising:

- a) a plurality of independent, separate computer systems, one for each of said parties, each said computer system being programmed to receive and process communication between parties and/or other information pertaining to each said party's preferences on the outcome of each variable involved in said negotiation problem, including proposals and confidential acceptance of any package;
- b) a plurality of interactive graphical interfaces connected, one for each of said independent and separate computer systems for input and output of information to and from the corresponding one of said computer systems;
- c) a central computer system located at a neutral site for
  - processing party preference information received from each of said independent separate computer systems;
  - maintaining each said party's preference information confidential from every other one of said parties;
  - receiving a confidential acceptable level of satisfaction for an agreement from one or more parties and, if they wish, their willingness for maximum possible corresponding satisfaction levels for other parties to be generated for and revealed to other parties;
  - using optimization with given said entered information to generate a fair distribution of maximum possible satisfaction levels for each other party for each given said confidential acceptable level of satisfaction declared by said one or more parties;
  - revealing said maximum possible satisfaction levels to said other parties, if so specified by the said one or more parties;
  - generating an equivalent package that would give at least as much satisfaction to all parties (or a subset if coalitions are allowed) as they have declared acceptable or, if that is not possible, then requiring one or more parties to reduce their declared minimum level of satisfaction before attempting again to generate said equivalent package, until successful;
  - if and when each of all said other parties to the negotiation (or a subset if coalitions are allowed) accept any said maximum satisfaction level revealed to that party, using optimization techniques with said entered information to generate an equivalent package that would give at least as much satisfaction to all parties as they have declared acceptable;
  - revealing any said equivalent package to all parties concerned; and



- declaring as a tentative agreement among two or more parties, any package that has been accepted by each of those parties.
- d) communication link means connecting each of said independent, separate computer systems with said central computer system;

16. The computer-based apparatus of claim 15, wherein said central computer system is further programmed for generating an improved package from said tentative agreement that is Pareto optimal (if not already) according to said entered preferences (or changed preferences).

17. A computer-based method for assisting at least two parties involved in a negotiation problem with any number of variables toward achieving an optimal, mutually satisfactory agreement on decisions to be taken on one or more of said variables comprising the steps of:

- a) providing a plurality of independent, separate computer systems, one for each of said parties, each said independent, separate computer system being programmed to receive and process information pertaining to each of said party's preferences on the outcome of each said variable involved in said conflict;
- b) providing a central computer system located at a neutral site and a plurality of communication links connecting each of said independent, separate computer systems to said central computer system, said central computer system being programmed to
  - receive preference information from each of said independent, separate computer systems;
  - not reveal any party's confidential information to other parties, and
  - generate at least one package representing a potential solution to the negotiation problem in response to entered preference information from each of said independent, separate computer systems;
- c) parties cooperating in creating a shared model of the negotiation problem and entering that information into one or more of their independent, separate computer systems;
- d) each party entering into their corresponding independent, separate computer systems,
  - any information required to define their private portion of the negotiation problem model;
  - any number of packages, which said packages may be private or not, and accepted or not; and/or

- any other information to be communicated to other parties;
- e) each party entering into their corresponding independent, separate computer systems, preference information including
- bargaining range information;
  - satisfaction function information;
  - information defining tradeoffs between variables;
  - an optional acceptable level of satisfaction for an agreement for which optimal ratings are to be generated for other parties;
  - an optional lower acceptable level of satisfaction for an agreement for which equivalent packages that would give at least that much satisfaction to each party are to be generated if possible; and/or
  - any other information from which such said preference information may be derived;
- f) transmitting said information from each of said independent, separate computer systems to said central computer system;
- g) said central computer system processing said transmitted preference information from all parties; including
- generation of said optimal ratings; and
  - generation of said equivalent packages;
- h) transmitting any said optimal ratings and said generated packages and any other said information to be communicated to other parties from the said central computer system to the appropriate said independent, separate computer systems;
- i) each party responding to said transmitted information by
- changing said preference information;
  - creating new packages;
  - accepting any number of packages; and/or
  - accepting any said optimal ratings;
- j) transmitting said response from each of said independent, separate computer systems to said central computer system;
- k) said central computer system declaring a tentative agreement if two or more parties have accepted the same package and transmitting that information to the appropriate said independent, separate computer systems; and
- l) repeating any of the above steps any number of times.

18. The computer-based method of claim 17, further including the steps of

- a) if two or more parties involved in said negotiation problem have both accepted any said package, then at the option of the parties, causing said central computer system to generate an improved package that is Pareto optimal (if not already) according to said entered preference information (or changed preference information); and
- b) repeating the above step any number of times;